PATENT SPECIFICATION

DRAWINGS ATTACHED

Inventors: DUNCAN EDWARD FARMAR CANNEY and FRANK DEREK WOOD

887,291

Date of filing Complete Specification: Nov. 8, 1960.

Application Date: Nov. 19, 1959. No. 39319/59.

Complete Specification Published: Jan. 17, 1962.

Index at acceptance:—Class 99(2), P1(A9: B7).

International Classification:—F06l.

COMPLETE SPECIFICATION

Improvements in or relating to Fire Hose

We, GEORGE ANGUS & COMPANY LIMITED, of Angus House, 152—158 Westgate Road, Newcastle-upon-Tyne 1, Northumberland, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention is concerned with fire hose of the type comprising two tubular components made separately and assembled one within the other. In known hose of this type both components have been designed to share the stresses due to hydraulic loading, whilst the outer component has had to be capable of resisting abrasion and the necessity for taking into consideration the factors of strength and abrasion resistance in designing the outer component has resulted in a compromise which does not realise the optimum qualities of either component. The object of the present invention is the provision of an improved fire hose of the above type which not only avoids this disadvantage but achieves certain valuable advantages not hitherto possible.

The invention provides a fire hose which is sufficiently flexible for it to be flaked or coiled and which comprises an inner woven textile jacket capable of withstanding the hydraulic forces to which the hose is subjected in use, a water-impervious lining within said inner jacket, and a water-impervious and abrasion-resistant outer jacket surrounding said inner jacket and in close contact therewith, said outer jacket being capable of circumferential expansion when the hose is under pressure to an extent at least as great as said inner jacket and consisting of a tubular body of flexible synthetic plastic material containing a loosely constructed textile fabric reinforcement of substantially the same thickness as said tubular body, said plastic material extending between the threads of said reinforcement so as thoroughly to impregnate the same.

The fire hose according to the invention thus differs from the known fire hoses including inner and outer jackets, in that both jackets in the known fire hoses are of woven fabric and share substantially equally the hydraulic forces on the hose, whereas in the hose according to the invention the inner jacket is capable of taking the whole of the hydraulic forces, the outer jacket being constituted by a reinforced plastic tube whose function is to resist abrasion and prevent access of water to the exterior of the inner jacket. Access of water to the interior of the inner jacket is, of course, prevented by its water-impervious lining. The outer jackekt contains a textile reinforcement, without which the plastic tube would tear and be unable to resist abrasion effectively. The reinforcement is, however, sufficiently loosely constructed to enable the plastic material to impregnate it thoroughly so ensuring that said outer jacket will be impervious to water. Provided the reinforcement fabric is not excessively tight, the threads thereof, and the filaments composing such threads when they are not monofilamentary, will be thoroughly impregnated by the plastic material. The thickness of the reinforcement is substantially the same as the thickness of the outer packet, with at most a thin skin of plastic above and below the reinforcement. As noted below, however, the outer jacket may be provided with a thin surface coating of plastic material, applied thereto to improve its appearance after manufacture of said outer jacket.

The hose according to the invention has the advantage over said known hose, that the known hose experiences loss in strength immediately the outer jacket begins to wear as the result of abrasion. The hose according to the invention retains its full strength, notwithstanding abrasion and wear of the

[*Price*

outer jacket, until the outer jacket is completely worn away because the inner jacket of itself is capable of withstanding the full hydraulic loads to which the hose is subjected in service.

The outer surface of the inner jacket should everywhere be in close contact with the inner surface of the outer jacket, although it is not essential that the two jackets should be positively attached to each other, and in order that such contact may be retained when the hose is at all pressures it is important that the two jackets should possess similar elastic properties, particularly in a hoopwise direction, and that the residual stretch after subjection to load should be no greater in the outer jacket than in the inner, so that the two jackets will remain in intimate contact.

The inner jacket may be of any suitable woven fabric possessing a tensile strength adequate to withstand the total hydraulic force up to burst, neglecting the minor contribution to the total strength which results from the mere presence of the outer jacket. It may be conveniently made entirely from synthetic yarns in such quantity as will satisfy the requirements of strength, having regard to the availability of known polyester and polyamide yarns which possess a superior strength/weight ratio and impart a greater degree of flexibility to the fabric than do most natural fibres. If desired, however, a substantial proportion of natural fibre yarns may be used, since the particular construction used for the outer jacket affords such high waterproofing qualities as substantially to avoid risk of damage to the inner jacket by mildew. On the other hand, the use of synthetic fibre yarns for the inner jacket is advantageous in that attack by mildew does not occur if the outer jacket is cut or otherwise so badly damaged as to permit its penetration by water.

The inner jacket is provided with a thin lining of rubber or any other material, e.g. polyvinyl chloride or other synthetic plastic material, which is impervious to water. Such lining may be formed in the manner described in Patent No. 538455.

The outer jacket is of flexible reinforced plastic, the reinforcement taking the form of a loosely constructed textile fabric, manufactured by weaving, knitting or any other known method.

One specific cloth which is appropriate for the reinforcement of the outer jacket is the following:—

Warp 8's count 8 ply cotton, woven one per male at 10½ ends per inch on the face.

Weft 24 ply 210 denier nylon woven at 8½ picks per inch.

If the threads of the reinforcement lie too closely together, and if they are too tightly twisted, complete impregnation by the plastic material may be difficult to achieve, and the result may be inadequate waterproofing of the cloth and fibres. Conversely, and as already noted, if the proportion of textile material in the outer jacket is too small, the finished hose will not possess satisfactory resistance to abrasion or tear.

Natural yarns used in the preparation of the reinforcement fabric may be protected from mildew attack by treatment with suitable fungicides, such as lauryl penta-chlorophenol.

The amount of plastic material picked up by the fabric reinforcement during the manufacture of the outer jacket depends on the nature of the fabric. Thus using polyvinyl chloride (p.v.c.) as the plastic material we have obtained a p.v.c. pick up of about 100% in the case of a cloth having a cotton warp and a nylon weft, while a p.v.c. pick up as high as 280% has been obtained with an all cotton fabric. The thickness of the p.v.c. above and below the cloth is negligible although, as later described, we prefer to apply to the outer jacket after the impregnation treatment a final outer coating of p.v.c. or the like.

The plastic material in the outer jacket may be of any suitable synthetic plastic material which is capable of impregnating the textile reinforcement fabric, rendering it waterproof and imparting to it the property of resistance to abrasion. It must remain flexible at all working temperatures and is desirably capable of maintaining its said properties during a reasonable working life. A material which has been found to possess these characteristics is polyvinyl chloride, a typical formulation being as follows:—

Chemical Name	Trade Name	Parts (by wt.)
Polyvinyl chloride paste making polymer	Geon 121	100
Dioctylphthalate	D.O.P.	68
Modified polypropylene adipate	Diolpate 195	20
Organo-tin stabiliser	Stanclere 70	1.5
Lauryl pentachloro-phenol	Mystox L.P.L.	0.5
Cadmium scarlet colouring	Cadmium Scarlet DC. 709	3

This formulation of polyvinyl chloride has good reaction to sunlight, is resistant to ageing, maintains its flexibility at extreme ambient temperatures and is fully capable of impregnating the reinforcing cloth when in paste form.

Our researches have shown, however, that a wide variety of synthetic plastic materials may be used for the manufacture of the outer jacket.

The following are examples of suitable synthetic plastic materials:—

Polyvinyl halides
Polyamides
Polychloroprene
Butadiene/methyl methacrylate copolymer
Polyurethane
Styrene/butadiene copolymer
Silicone elastomers
P.V.C. with cross-linked plasticisers.
P.V.C. copolymers
P.V.C. with reinforcing fillers
P.V.C./nitrile rubber latex blends
Chlorinated rubbers
Epoxy resins
Polyethylene—a) alone
b) modified with, for example, butyl rubber
Polypropylene—a) alone
b) modified

Typical examples of suitable inner jackets are the following:—

TYPE A

Warp

Material	Terylene (Registered Trade Mark) Filament	Nylon Staple
Count	250 denier	3½ cotton count
Ply	10	2
Twist	4½ (Z)	4 (S)
Face ends/inch 12½		
Ends/male	1 Filament and 1 Staple	
Warp %	65.54	
Tension	2 lbs.	1 lb.

TYPE A—*cont.*

Weft

Material	Nylon 600	Nylon Staple
Count	840 denier	3½ c.c.
Ply	7	1
Twist	1.75 Filament and Staple together	
Picks/inch	12½	
Weft %	34.46	
Tension	3 lbs.	

The woven diameter of this jacket is 2 $^{23}/_{32}$ inch and the weight per foot is 0.1860 lbs. The total warp ends are 225 terylene filament and 225 nylon staple.

TYPE B

Warp		Weft	
Material	Cotton, Grade A	Material	Nylon 600
Count	8's	Count	840 den.
Ply	8	Ply	9
Twist	4 ± .2	Twist	1.75
Face ends/inch	12	Picks/inch	10
Ends/male	2		
Warp %	79.99	Weft %	20.01
Tension	6½ lbs. on 2 ends	Tension	4¼ lbs.

The woven diameter of this jacket is 2 $^{11}/_{16}$ inch and the weight per foot is 0.2554 lbs. The total warp ends are 432.

To recapitulate, the outer jacket is essentially a textile tube impregnated with a flexible plastic and can be constructed from a number of different textile arrangements combined with a suitable plastic. It is essential that the finished article should be:—

(a) Waterproof to a considerable degree.
(b) Sufficiently flexible to allow the hose to be flattened and coiled easily.
(c) Of an adequate abrasion resistance.
(d) Sufficiently elastic to follow the swell and extension of the inner hose, under water pressure, without fracturing.

In addition it is an obvious requirement, under certain conditions, for the outer cover to remain flexible at low temperatures and to resist the action of oils, petrols and chemicals of various kinds.

A number of typical examples of suitable outer jackets will now be given, together with the water pick-up and abrasion resistance of said outer jackets when tested by the following methods:—

Water Pick-up Test.

24" long samples of lined and completed

hose are folded so that 2" at each end is bent at right angles to the remainder of the hose and the 20" length remaining is immersed horizontally in a tray of water so that 50% of the surface area of the hose pipe is under the surface of the water. The moisture pick-up is determined after 24 hours and the results are expressed on the bone dry weight of the hose.

Abrasion Test.

A length of completed hose 18" long is fitted with couplings, filled with water, and subjected to a hydraulic pressure of 85 p.s.i.

The hose is arranged so that it is well supported and two pencil lines are marked across the hose on its upper surface spaced 5" apart.

A 12" hand file 1 3/16" wide x 17/64" thick, single cut at 8½ cuts per inch, weighted with a 5 lb lead weight is used to abrade the hose. The operator does not exert any pressure on the file, but merely guides it backwards and forwards in horizontal plane, allowing the lead weight to supply the pressure. Each forward movement of the file is arranged to commence at one of the pencil lines and terminate at the other and the complete outward and return cycle is counted as one stroke for recording purposes.

The operator files at a rate of approximately 80 complete strokes per minute and counts the number of strokes which he makes. At the end of each 50 strokes the file is cleaned with a stiff wire brush and the total number of strokes is noted. The test continues until the jacket is worn completely through at any point in the area being abraded.

The following are dtails of specific outer jackets, parts being in all cases parts by weight:—

TYPE A.

Textile Tube Construction.

Warp: 250 total ends of 8's count 8 ply cotton yarn having a doubling twist of 2.25 turns per inch.

Weft: 5 ply 840 denier nylon with a doubling twist of 1.75 turns per inch woven at 8½ picks per inch.

Type of weave: Plain.

Internal diameter of tube: 3".

Weight perfoot (as woven): 0.158 lbs.

Plastic Compound.

Polyvinyl Halide.

e.g.		
Geon 121	100	parts
Diolpate 195	20	„
Dioctylphthalate	68	„
Stanclere 70A	1.5	„
Mystox L.P.L. 100%	1.9	„
Cadmium Scarlet DC 709	3	„
Toluene	99	„

The textile tube was impregnated with the plastic compound and subsequently gelled by the methods disclosed below. The pick-up of plastic was 90% by weight on the weight of the textile prior to final coating, which added another 30%.

The abrasion resistance of a hose having an outer jacket of this construction was found to be 1700 file strokes (i.e. only to wear through outer jacket).

The water pick-up was 1¼% on the weight of hose, i.e. 2.5% on the weight of the outer jacket.

TYPE B.

Textile Tube Construction.

As for Type A but 192 warp ends.
Weight per foot (as woven): 0.127 lbs.

Plastic Compound.

Polyamide.

e.g.		
"Maranyl" nylon compound C.109/P.	20	parts
Water	30	„
Industrial Methylated Spirit	70	„
Citric Acid	0.5	„

The textile was impregnated and then dried at 120°C for 25 minutes to crosslink and insolubilise the polyamide.

The dry weight pick-up was 50%.
Abrasion resistance was 700 file strokes.

TYPE C.

Textile Tube Construction.

As for Type B.

Plastic Compound.

Polyamide.

e.g.

As in Type B but incorporating 10% by weight of rubber dust in the impregnant.
Abrasion resistance was 700 file strokes.

TYPE D.

Textile Tube Construction.

As for Type B.

Plastic Compound.

Polychloroprene.

e.g.

Neoprene Latex 601A.	320	parts
50% solution Notac LM	6	„
60% solution Vulcafor HS	4	„
50% solution Sodium Hydroxide	10	„
Zinc Oxide	29	„
Agerite White	4	„
Sulphur	2	„
Vulcafor TC	2	„
Dispersol L	3	„
Water	40	„
Carbon Black	12	„

Abrasion resistance was 800 file strokes.

TYPE E.

Textile Tube Construction.
As for Type B.

Plastic Compound.

Copolymer of Butadiene and Methyl Methacrylate.

e.g.

Butadiene/methyl methacrylate copolymer latex such as Butakon ML.501 having a solids content of approximately 46% wt./wt.

The textile was impregnated and the aqueous dilent dried off at 70°C. Dry weight pick-up 100%.

Abrasion resistance was 1000 file strokes.

TYPE F.

Textile Tube Construction.
As for Type B.

Plastic Compound.

Copolymer of Butadiene/methyl methacrylate.

Improvements can be obtained in the plastic if it is compounded with conventional curing agents in order to make it vulcanize.

e.g.

	Parts by Weight	
	Dry	Wet
Butakon Latex ML 501 (45% solids)	100	220
Casein (15% ammoniated soln.)	0.5	3.3
Vulcastab LW (20% dispersion)	0.2	1.0
Vulcafor ZDC (5% dispersion)	2.0	4.0
Sulphur (50% dispersion)	1.0	2.0

The textile was impregnated to give 100% dry weight pick-up and the impregnant cured by drying at 70°C and curing at 130°C for 5 minutes.

Abrasion resistance was 1,200 file strokes.

TYPE G.

Textile Tube Construction.
As for Type B.

Plastic Compound.

Polyurethane.

e.g.

Oil-free ALKYD resin e.g. Daltolac 10	44.4	parts
Methyl ethyl ketone	22.2	„
Butyl acetate	22.2	„
55% solution in xylene of di - isocyanatodiphenyl-methane, e.g. *"Suprasec" DX	20.4	„

The textile was impregnated to give a 100% dry weight pick-up. The solvent was allowed to evaporate and the impregnant cured at 120°C for 45 minutes.

Abrasion resistance was 900 file strokes.

* Registered Trade Mark—Imperial Chemical Industries Limited.

TYPE H.

Textile Tube Construction.
As for Type B.

Plastic Compound.
Plasticised Polyurethane.

To increase flexibility and tear strength it is useful to plasticise Type H.

e.g.

Daltolac 10	24.8	parts
Methyl ethyl ketone	49.8	„
Suprasec DX	11.4	„
Plasticising resin e.g. Daltolac 315	13.6	„
Finely divided silica (Silica Aerogel), e.g. Santocel *CX	5.0	„

Impregnation and curing as Type G.
Abrasion resistance was 700 file strokes.
* "Santocel" Registered Trade Mark: Monsanto Ltd.

TYPE J.

Textile Tube Construction.
As for Type B.

Plastic Compound.
Styrene/Butadiene Copolymer.

e.g.

(47% solids) Styrene/Butadiene Copolymer latex (60% Styrene) e.g. Monsanto Latex SB2	156	parts
Whiting	75	„
Water	25	„
Dispersol L	0.75	„

The textile was impregnated to give 100% dry weight pick-up and then the jacket was dried at 70°C.
Abrasion resistance was 900 file strokes.

TYPE K.

Textile Tube Construction.
As for Type B.

Plastic Compound.
Styrene/Butadiene Copolymer

Modification of degree of hardness by increase of styrene content.

e.g.

(47% solids) Styrene/Butadiene Copolymer latex (60% styrene) e.g. Monsanto SB2	78	parts
(30% solids) Styrene/Butadiene Copolymer latex (85% styrene) e.g. Monsanto SB 3	124	„
Whiting	75	„
Water	25	„
Dispersol L	0.75	„

Impregnation as for Type J.
Abrasion resistance was 800 file strokes.

TYPE L.

Textile Tube Construction.
As for Type B.

Plastic Compound.
Styrene/Butadiene Copolymer modified with Butadiene/Styrene (S.B.R.) Latex.

e.g.

47% solids Styrene/Butadiene Copolymer latex (60% Styrene) e.g. Monsanto SB2.	78	parts
60% solids Butadiene/Styrene latex (23% Styrene) e.g. Intol	62	„
Whiting	75	„
Water	25	„
Dispersol L	0.75	„

Impregnation as for Type K.
Abrasion resistance was 800 file strokes.

TYPE M.

Textile Tube Construction.
As for Type B.

Plastic Compound.
Silicone Elastomers.

Only one tried was a cold cure elastomer based on

Cold Cure Silastomer 9161—	100	parts
Curing Catalyst No. N.9162—	2	„

Textile impregnated—obtained 200% dry weight pick-up. Allowed to stand overnight at room temperature to complete cure.
Abrasion resistance was 1,100 file strokes.

A tube of the polyvinyl chloride composition utilised in the type A jacket and of the same thickness as the jacket had an abrasion resistance of 126 strokes only. The textile reinforcement utilised in the type A jacket and unimpregnated with synthetic plastic material had an abrasion resistance of 220 strokes only. It will be noted that the textile reinforced plastic outer packets of types A—M have abrasion resistances ranging from 700—1200 strokes, which demonstrates the surprising fact that the abrasion resistance of the plastic-fabric combination is far in excess of the sum of the abrasion resistances of the individual components.

A preferred method of manufacturing fire hose according to the invention will now be described with reference to the accompanying drawings, in which:—

Fig. 1 is a cross section through the hose, and

Figs. 2—4 are diagrams illustrating its manufacture.

The hose 15 shown in Fig. 1 has an inner woven jacket 10, of thickness .055",

the warps being indicated at 11, and the weft at 12, a rubber lining, 13 of thickness 0.040" and an outer jacket 14, of thickness .084" and consisting of plastic material having a woven textile reinforcement 16, the warps of which are indicated at 17 and the weft at 18. Both the warp and the weft of the reinforcement are thoroughly impregnated by the plastic material which also extends between the adjacent threads as shown.

The hose shown in Fig. 1 may be manufactured as follows:—

The tubular cloth 16 which is to constitute the reinforcement of the outer jacket is drawn through a bath 19 (Fig. 2) of p.v.c. by mangle rollers 20 which squeeze off the excess plastic material. The lined inner jacket 10 is then drawn into the tube of cloth so impregnated, the inner jacket being folded to kidney shape, as shown in Fig. 3, and held in this configuration by a light string 21, which breaks when the hose is put under pressure. The resulting assembled hose 15 is then inflated by air from a head 22 (Fig. 4) and kept taught by a weight W, and a hot air curing oven 23 is then traversed along the hose to gel the p.v.c. in the outer jacket. Finally the hose is given an outer finishing coat of p.v.c. by means of a conventional coating plant. Where the plastic in the outer jacket is not polyvinyl chloride, the outer coat is of the same plastic as that in the outer jacket or any plastic material compatible therewith.

A fire hose manufactured in the manner herein described possesses the following important advantages:—

(a) The inner jacket possesses optimum strength to withstand hydraulic loads, for which reason the strength of the hose remains unimpaired until the outer jacket is worn completely away, unless damaged by cuts or in some other way than by abrasion.

(b) The outer jacket possesses optimum resistance to abrasion.

(c) The complete protection against ingress of moisture provided by the outer jacket obviates the need for drying until the outer jacket is worn through or otherwise punctured.

(d) Substantially complete protection of natural fibres against attack by mildew is afforded by the impregnation by the plastic of the textile constituents of the outer jacket, these textile constituents having been preferably treated with a fungicide as already stated. Any slight mildew which may occur is unimportant because the outer jacket is not subjected to load.

(e) The high degree of flexibility permits easy flaking or coiling.

(f) Cleaning of the hose is facilitated as dirt cannot penetrate the outer jacket and surface dirt can be easily removed with a damp cloth.

(g) A high resistance against attack by certain chemicals including the following is obtained:—

Dilute acids and alkalis, petrol, grease and oil, dilute reducing agents.

WHAT WE CLAIM IS:—

1. A fire hose which is sufficiently flexible for it to be flaked or coiled and which comprises an inner woven textile jacket capable of withstanding the hydraulic forces to which the hose is subjected in use, a water-impervious lining within said inner jacket, and a water-impervious and abrasion-resistant outer jacket surrounding said inner jacket and in close contact therewith, said outer jacket being capable of circumferential expansion when the hose is under pressure to an extent at least as great as said inner jacket and consisting of a tubular body of flexible synthetic plastic material containing a loosely constructed textile fabric reinforcement of substantially the same thickness as said tubular body, said plastic material extending between the threads of said reinforcement so as thoroughly to impregnate the same.

2. A fire hose according to claim 1, wherein the reinforcement of said outer jacket is a loosely woven textile fabric.

3. A fire hose according to claim 1, wherein the reinforcement of said outer jacket is a knitted fabric.

4. A fire hose according to claim 1, wherein said outer jacket has a thin surface coating of flexible synthetic plastic material.

5. A fire hose according to claim 1, wherein the inner jacket is woven from synthetic yarn, the warps consisting in part at least of staple synthetic fibres.

6. A fire hose according to claim 5, wherein the warps of the inner jacket consist of polyester filaments and nylon staple fibres and the weft of nylon filaments and nylon staple fibres.

7. A fire hose according to claim 1, wherein the warps of the inner jacket are of cotton and the weft of nylon.

8. A fire hose according to claim 2, wherein the warps of the reinforcement of the outer jacket are of cotton and the weft of nylon.

9. A fire hose according to claim 1, in which the synthetic plastic material is selected from the group consisting of polyvinyl halides, polyamides, polychloroprene, copolymers of butadiene and methyl methacrylate, polyurethanes, copolymers of butadiene and styrene and silicone elastomers.

10. A fire hose according to claim 1, wherein the abrasion resistance of the outer jacket as determined by the abrasion test herein specified is at least 700 strokes.

BREWER & SON,
Chartered Patent Agents,
5—9 Quality Court,
Chancery Lane,
London, W.C.2.

PROVISIONAL SPECIFICATION

Improvements in or relating to Fire Hose

We, GEORGE ANGUS & COMPANY LIMITED, of Angus House, 152—158 Westgate Road, Newcastle-upon-Tyne 1, Northumberland, a British Company, do hereby declare this invention to be described in the following statement:—

The invention is concerned with the manufacture of fire hose of the type in which the hose comprises two tubular components made separately and assembled one within the other. In known hose of this type both components have been designed to share the stresses due to hydraulic loading, whilst the outer component has had to be capable of resisting abrasion; the necessity for taking into consideration the factors of strength and abrasion resistance in designing the outer component has resulted in a compromise which does not realise the optimum qualities of either component. The object of the present invention is the provision of an improved manufacture of fire hose of the above type which will not only avoid the disadvantage referred to but will achieve certain valuable advantages not hitherto possible.

According to the invention a fire hose comprises two tubular components disposed one within the other, the inner component being provided with a water impervious lining and being capable in itself of withstanding substantially the whole of the hydraulic forces up to burst, whilst the outer tubular component has for its sole functions those of resistance to abrasion and the prevention of ingress of moisture for which purpose said abrasion-resistant, waterproof outer component consists of a suitable plastic material, such as polyvinyl chloride or other suitable flexible polymer, incorporating a reinforcement of loosely constructed textile fabric reinforcement of such nature that the threads thereof, and the filaments composing such threads when these are not monofilamentary, are thoroughly impregnated by the plastic material.

The outer surface of the inner component should everywhere be in close contact with the inner surface of the outer component, although it is not essential that the two components should be positively attached to each other, and in order that such contact may be retained when the hose is at all pressures it is important that the two components should possess similar elastic properties, particularly in a hoopwise direction, and that the residual stretch after subjection to load should be no greater in the outer component than in the inner, so that the two components will remain in intimate contact.

The inner component may be of any suitable woven fabric possessing a tensile strength adequate to withstand the total hydraulic force up to burst, neglecting the minor contribution to the total strength which results from the mere presence of the outer component. It may conveniently be made entirely from synthetic yarns in such quantity as will satisfy the requirements of strength, having regard to the availability of known polyester and polyamide yarns which possess a superior strength/weight ratio and impart a greater degree of flexibility to the fabric than do most natural fibres. If desired, however, a substantial proportion of natural fibre yarns may be used, since the particular construction used for the outer component affords such high waterproofing qualities as substantially to avoid risk of damage to the inner component by mildew. On the other hand, the use of synthetic fibre yarns for the inner component is advantageous in that attack by mildew does not occur if the outer component is cut or otherwise so badly damaged as to permit its penetration by water.

The inner fabric tube is provided with a lining of rubber or any other material which will be impervious to water. Such lining may be formed in the manner described in our prior Patent Specification No. 538455.

The outer tubular component is of flexible reinforced plastic, the reinforcement taking the form of a loosely constructed textile fabric, manufactured by weaving, knitting or any other known method.

The reinforcement fabric is preferably a woven fabric having an apparent density (i.e. a weight per unit volume of the material as woven) within the limits 0.25—0.6 gms/cc and is thus very different from a conventional fire hose fabric which has an approximate apparent density of 1.00. While this definition does not completely define the cloth, since the apparent density also depends upon the spacing of the threads in the warp and weft directions and upon the materials of which the warp and weft threads are constructed, the above limits are generally appropriate both for all-cotton cloth and all-nylon cloth and

crosses between them. One specific cloth which is appropriate for the reinforcement of the outer component is the following:—

Warp 8's count 8 ply cotton, woven one per mail at 10½ ends per inch on the face.

Weft 24 ply 210 denier nylon woven at 8½ picks per inch.

If the threads of the reinforcement lie too closely together, and if they are too tightly twisted, complete impregnation by the plastic material will not be achieved, resulting in inadequate waterproofing of the cloth and fibres. Conversely, if the proportion of textile material in the outer component is too small, the finished hose will not possess satisfactory resistance to abrasion or tear.

Natural yarns used in the preparation of the reinforcement fabric may be protected from mildew attack by treatment with suitable fungicides, such as lauryl penta-chlorophenol.

The amount of plastic material picked up by the fabric reinforcement during the manufacture of the outer component depends on the nature of the fabric. Thus using polyvinyl chloride (p.v.c.) as the plastic material we have obtained a p.v.c. pick up of about 100% in the case of a cloth having a cotton warp and a nylon weft, while a p.v.c. pick up as high as 280% has been obtained with an all cotton fabric. The thickness of the p.v.c. above and below the cloth is negligible although, as later described, we prefer to apply to the outer component after the impregnation treatment a final outer coating of p.v.c. or the like.

The plastic material in the outer component may be of any suitable plastic polymer which is capable of impregnating the textile reinforcement fabric, rendering it waterproof and imparting to it the property of resistance to abrasion. It must remain flexible at all working temperatures and is desirably capable of maintaining its said properties during a reasonable working life. A polymer which has been found to possess these characteristics is polyvinyl chloride, a typical formulation being as follows:—

Chemical Name	Trade Name	Parts (by wt.)
Polyvinylchloride paste making polymer	Geon-121	100
Dioctylphthalate	D.O.P.	68
Modified polypropylene adipate	Diolpate 195	20
Organo-tin stabiliser	Stanclere 70	1.5
Lauryl pentachloro-phenol	Mystox L.P.L.	0.5
Cadmium scarlet colouring	Cadmium Scarlet DC. 709	3

This formulation of p.v.c. has good reaction to sunlight, is resistant to ageing, maintains its flexibility at extreme ambient temperatures and is fully capable of impregnating the reinforcing cloth when in paste form.

The hose according to the invention may be manufactured as follows:—

The tubular cloth which is to constitute the reinforcement of the outer component is drawn through a bath of p.v.c. by mangle rollers which squeeze off the excess plastic material. The lined inner component is then drawn into the tube of cloth so impregnated. The resulting assemblage is then inflated by air and an infra-red curing oven is then traversed along the hose to cure the p.v.c. in the outer component. Finally the hose is given an outer finishing coat of p.v.c. by means of a conventional coating plant.

A fire hose manufactured in the manner herein described possesses the following important advantages:—

(a) The inner component possesses optimum strength to withstand hydraulic loads, for which reason the strength of the hose remains unimpaired until the outer component is worn completely away, unless damaged by cuts or in some other way than by abrasion.

(b) The outer component possesses optimum resistance to abrasion.

(c) The complete protection against ingress of moisture provided by the outer component obviates the need for drying until the outer jacket is worn through or otherwise punctured.

(d) Substantially complete protection of natural fibres against attack by mildew is afforded by the impregnation by the plastic of the textile constituents of the outer component, these textile constituents having been preferably treated with a fungicide as already stated. Any slight mildew which may occur is unimportant because the outer component is not subjected to load.

(e) The high degree of flexibility permits easy flaking or coiling.

(f) Cleaning of the hose is facilitated as dirt cannot penetrate the outer jacket and surface dirt can be easily removed with a damp cloth.

(g) A high resistance against attack by certain chemicals including the following is obtained:— Dilute acids and alkalis petrol, grease and oil, dilute reducing agents.

BREWER & SON,
Chartered Patent Agents,
5—9 Quality Court,
Chancery Lane,
London, W.C.2.

Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1962.
Published by The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

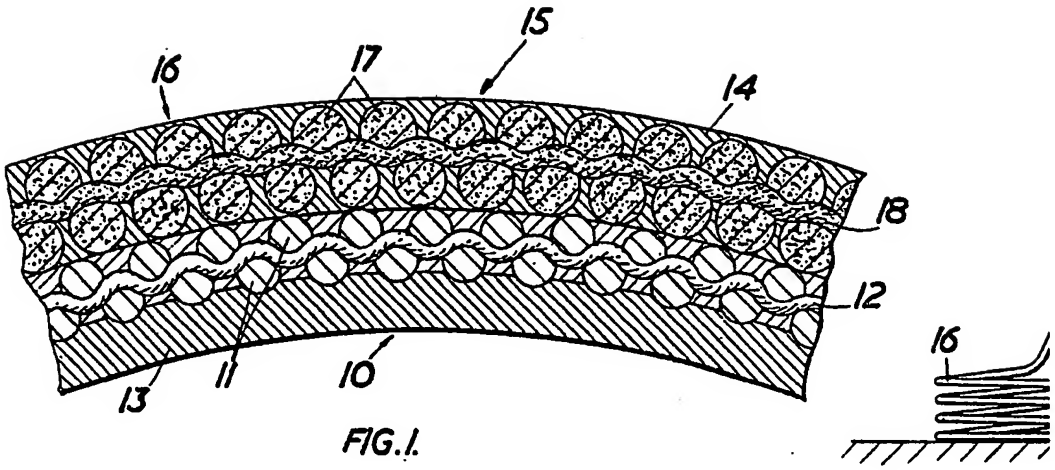

FIG. 1.

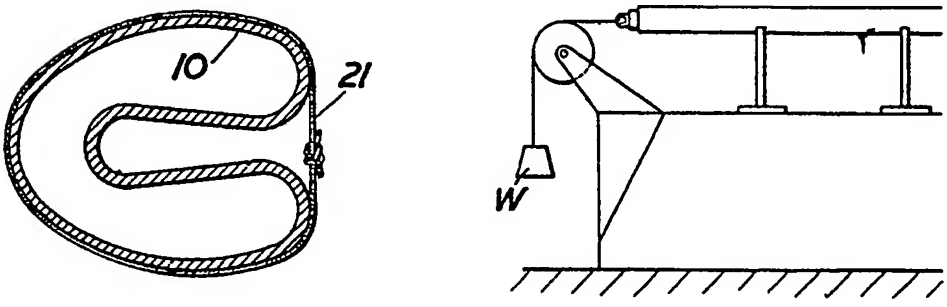

FIG. 3.

887,291 COMPLETE SPECIFICATION

1 SHEET

This drawing is a reproduction of the Original on a reduced scale.

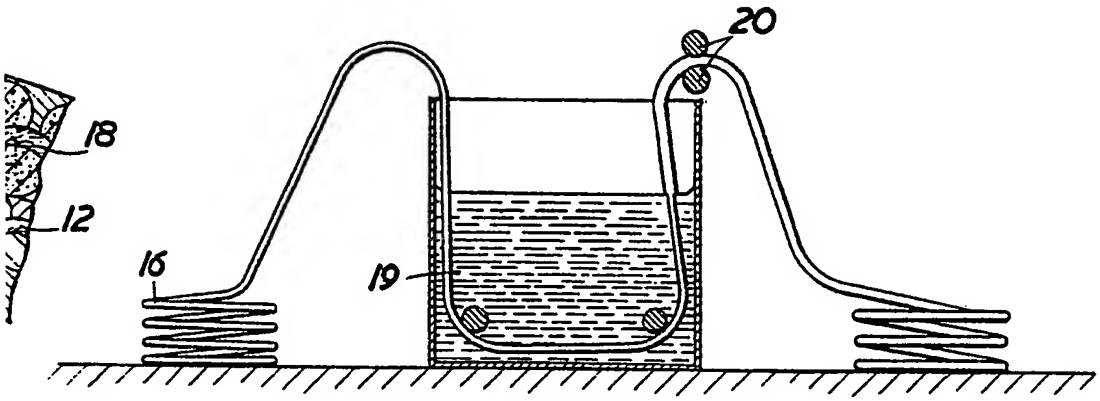

FIG.2.

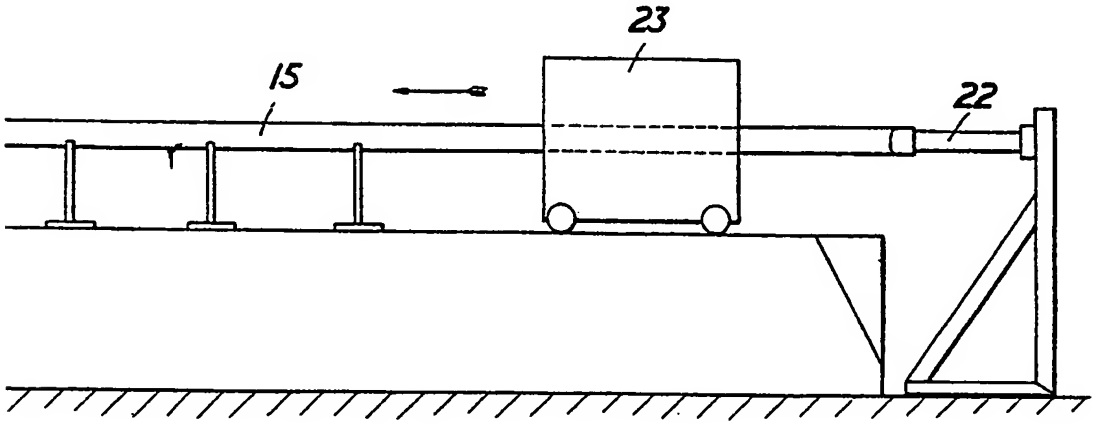

FIG.4.

887,291 COMPLETE SPECIFICATION
1 SHEET This drawing is a reproduction of the Original on a reduced scale.

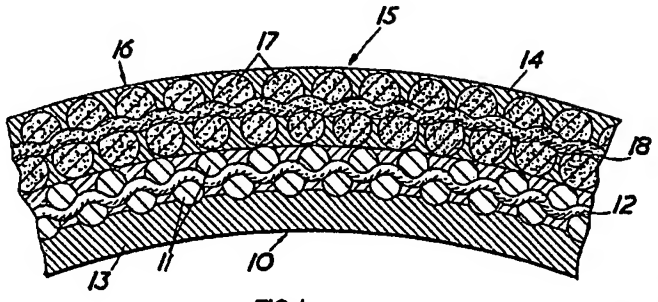

FIG.1.

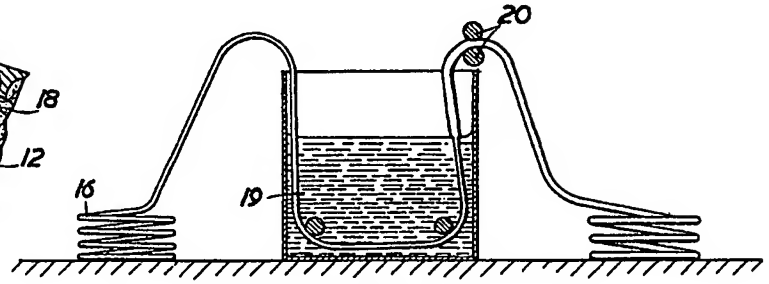

FIG.2.

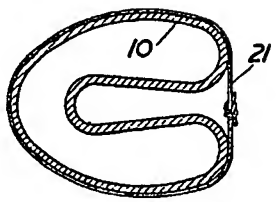

FIG.3.

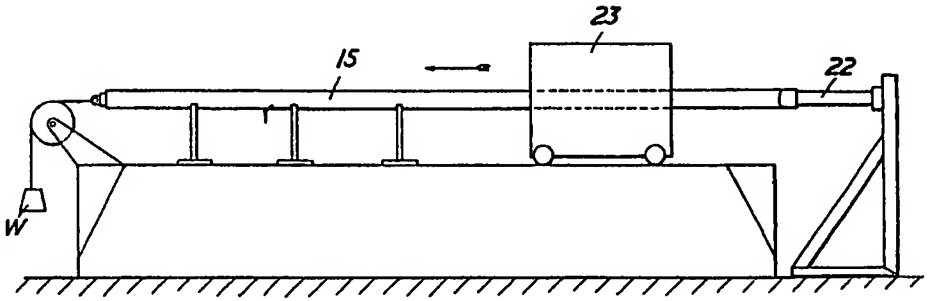

FIG.4.